THE LIFE HISTORY AND BIOLOGY OF TWO PARASITES OF AQUATIC INSECT EGGS.

By

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Introduction.

The material and a part of the data for the following studies were gathered at the Biological Station of the University of Michigan which is located on Douglas Lake, Michigan. The Lake is situated in the upper part of the lower peninsula of Michigan, about fifteen miles south of the Straits of Mackinac. On the older maps of the locality this lake was called Turtle Lake. The region is of recent glacial origin, lying at the southern edge of the Boreal Life Zone. Sandy moraines cover the area which is a cut over pine district. A few pines still stand but the aspen association is the prominent one of the uplands. The region abounds with numerous bogs and swamps in various stages of development. The lake itself is said to resemble a fish in outline with the tail toward the south-east. The main axis of the lake is a little over four miles in length and takes nearly the same direction as that of the prevailing winds which are from the north-west nine months of the year. The shores are of fine white sand and with a considerable growth of Scirpus along sheltered places. At one point the Scirpus extends into the lake going almost across. At this particular place the water is not over eight feet in depth.

The Scirpus offered an excellent place for *Sialis infumata* Newn., *Chrysops striatus* O.S., *Chrysops excitans* Walk., and some Tabanus to deposit their eggs. It was the finding of the parasites on Chrysops egg masses by Dr. H.B.Hungerford that later led to the author working on the life history of this parasite. The work was done under his direction. While working with this life history, eggs of other aquatic insects were also collected, which led to the finding of the Gerrid Egg Parasite, *Tiphodytes gerriphagus*(Marchal). This parasite has been reported only once before here in America. Mathewson and Crosby (22) found it parasitizing Gerrid eggs at Ithaca, New York in 1912.

Several other such egg parasites should be found in this region. The following are some reported from New York: *Prestwichia aquatica* Lubb., parasitic on the eggs of Ranatra, Dytiscus, Agabus, Notonecta, dragonflies and others; *Caraphractus cinctus* Walker, parasitic on the eggs of Notonectidae; *Hydrophylax aquivolans* Mathewson and Crosby, parasitic on the eggs of Ischnura.

In addition to working on the life histories of the above mentioned parasites it was possible to take some valuable and interesting notes on the egg laying habits and on the copulation of *Sialis infumata* Newn. which was so common along the shores of the lake at the beginning of of the season.

Trichogramma minutum Riley.(Family Chalcidae)

This very common egg parasite,one of the smallest known insects,was figured and described by Riley in the "Third Report on Insects of Missouri." The material that he had emerged from the eggs of Basilarchia archippus Cram. that were collected in Missouri. Girault[7] says that the following are synomic species: pretiosum,minutissium,intermedium and odontotae. The types of the species in synomnomy were lost or never deposited. T. odontotae Howard is a doubtful synonym of T. minutum in that this particular form has been reared from only the one host.

The species is recorded from both Hemispheres. The following is a list from Girault.

Western Hemisphere.

North America.

United States,Canada, and West Indies.

Eastern Hemisphere.

Europe/

Germany,Austria.

New Zealand.

Waikumate and Wellington.

Java.

Hawaii.

As the known distribution is so wide spread, no doubt further collecting will show that this tiny insect is cosmopolitan in its range. Girault seems to think that "food is a factor of more than usual importance in limiting its range."

Host Records of *Trichogramma minutum* Riley.

This egg parasite is known to parasitize well over one hundred fifty hosts in seven orders; Lepidoptera, Coleoptera, Hymenoptera, Megaloptera, Neuroptera, Diptera and Hemiptera(?). Known records indicate that Lepidoptera are the favored hosts. In the partial list gathered fro literature at hand there are forty-six species of Lepidoptera recorded as hosts out of the list of sixty-four species.

Girault[7] states that the largest numbers of this parasite's hosts are lepidopterous and later points out that the Coleoptera and Hymenoptera hosts are closely related to moths and butterflies. In the same paper he makes the statement that all the hosts' larvae "feed upon foliage of various trees and plants ------- none are woodboring, carniverous or predaceous in the larval stages." In the same paper he then lists as a host *Chauloides rasticornis* Rambur, a Megaloptera whose larva *is* predaceous. The author is able to report another Megaloptera that serves as a host, *Sialis infumata* Newn. (Family Sialidae). So far as we are aware,no one has listed this genus as a host. In 1922 Smith[16] reported that it parasitized the eggs of Chrysopidae(Order Neuroptera).

Tabanidae(Order Diptera) was first reported as a host by Cameron[3] in July,1926. Chrysops mitis O.S.,Chrysops moerens Walk.,Tabanus phaenops O.S., Tabanus punctifer O.S., were recorded as hosts,to which list we add the following as hosts not listed before;Chrysops excitans Walk.,Chrysops striatus O.S.,and Tabanus lasiophthalmus Macq.

A European writer,Kryger,[15] has reported Trichogramma evanescens West. as a parasite on the eggs of Sialis lutaria L.(both European species). He also listed Tabanidae and Stratiomyidae eggs serving as hosts for T. evanescens; so it is very probable that T. minutum will sometime be found parasitizing the egg of Stratiomyidae in this country.

The Order Hemiptera is listed with a question mark as we have only the information from a correspondent that he has been working with Trichogramma sp? that were parasitic on lepidopterous and hemipterous eggs (Mr.C.O.Bare, Tampa,Fla.) Cameron says that Hemiptera eggs are parasitized but does not cite any species or references.

The following is a partial host list made from the literature listed in the bibliography* at the end of this paper.

Host List of *Trichogramma minutum* Riley.

ORDER COLEOPTERA.

Family Chrysomelidae.

Odontota dorsalis Thunberg.
Odontota suturalis Thunberg.

ORDER LEPIDOPTERA.

Family Papilionidae.

Papilio glaucus Linn.
Papilio glaucus turnus Linn.

Family Nymphalidae.

Polygonia interrogationis Fabr.
Vanessa atalanta Linn.
Agraulis vanillae Linn.
Aglais milberti Godart.
Basilarchia archippus Cramer.

Family Lymnadidae.

Danaus plexippus Linn.

Family Tortricidae.

Tortrix fumiferana Clemens.
Tortrix citrana Fernald.
Platynota rostrana Walk.
Polychrosis botrana Schiff.
Archips rosaceana Harris.
Laspeyresia pomonella(Linn.)
Bactra lanceolima Hub.

*This list is largely from Girault.

Family Pyralidae.

<u>Phlyctaenia ferrugalis</u> Hub.
<u>Pyrausta nubialis</u> Hub.

Family Pieridae.

<u>Eurynus eurytheme</u> Boisd.
<u>Pontia rapae</u> Linn.

Family Agapetidae.

<u>Oenis macountii</u> Edwards.

Family Hesperidae.

<u>Calpodes ethlius</u> Cramer.
<u>Thanaos lucilius</u> Litner.
<u>Goniurus proteus</u>(L.)

Family Sphingidae.

<u>Smerinthus sp.</u>
<u>Phelethontius sexta</u> Johanssen.
<u>Ceratomia catalpae</u> Bois.

Family Notodontidae.

<u>Datana integerrima</u> G.&R.
<u>Ianassa lignicolor</u> Walk.

Family Liparidae.

<u>Euprostis chrysorrhea</u> Linn.

Family Noctuidae.

<u>Omiodes meyricki</u>
<u>Omiodes blackburnii</u>
<u>Omiodes accepta</u>

Family Noctuidae cont.

Peridoma margaritosa caucia Hub.
Aletia argillacea Hub.
Plusia brassicae(Riley).
Heliothis obsoleta Fab.
Heliothis armigera
Laphygma frugiperda S.&A.
Mamestra picta Harris.
Plathypena scabra Fabr.

Family Arctiidae.

Hyphantria cunea Drury.
Hyphantria textor Harris.
Estigeme acreae Drury.

Family Ceratocampidae.

Anisota senatoria S.&A.

Family Crambidae.

Diatraea saccharalis Fab.
Diatraea striatalis

ORDER HYMENOPTERA.

Family Selandriidae.

Eriocampoides limacina(Retzius).

Family Tenthredinidae.

Caliroa obsoleta Norton.
Caliroa aethiops Fabricus.

Family Nematidae.

? Pachynematus palliventris Cresson.
Pteronus ribesii Scopoli.

Family Cimbicidae.

Cimbex americana Leach.

ORDER MEGALOPTERA.

Family Sialidae.

Chauliodes rastricornis Rambur.
Sialis infumata Newn.

ORDER NEUROPTERA.

Family Chrysopidae.

Chrysopa spp.

ORDER DIPTERA.

Family Tabanidae.

Chrysops mitis O.S.
Chrysops moerens Walk.
Chrysops striatus O.S.
Chrysops excitans Walker.
Tabanus phaenops O.S.
Tabanus punctifer O.S.
Tabanus lasiophthalmus Macq.

Collecting and Cage Technique.

Adults of the parasite were first obtained by placing the egg masses of <u>Sialis infumata</u> in four ounce homeopathic vials. The mouth of the bottle was covered with a bit of cloth,held in place by a rubber band. Moist sand was kept in the first cages but this was soon abandoned as fungus growths became quiet heavy in some of the cages. The best results were obtained in cages that were dry,the moisture from the eggs and bits of plant stem seeming to be sufficient to keep the eggs in proper condition for the developing parasites and host embryos. Life history cages were also kept dry. Later in the season adults of the parasite were collected in the field while ovipositing in the egg masses of Chrysops.

The first emergence in the cages was that of a lone, winged female. This individual appeared on the twenty-sixth of June,dieing two days later,imprisoned in some of the fungus growth that had started in the cage. No others emerged in this cage until seven days later. The first insects were wingless males;an hour or so later winged females appeared. At a later date wingless females were found but no winged males were ever found. An examination of the wingless individual showed that they possessed tiny, round scales attached to the points on the thorax where the wing bases are attached in winged specimens. These scales, or rudiments of wings, would float at right angles to the thorax when the insect was placed under water.

The males did not always emerge ahead of the females. At times the females were found in the cages an hour or two before the appearance of the males and were observed to oviposit many times before copulating with the late appearing males. Authors say that the species is parthenogenetic.

Two winged females were taken from cages, that have their antennae densely clothed with long hairs. One emerged from material that was collected early in the season and the other emerged from material that was collected late in the season. (See plate I, fig. 3).

Cage Counts.

Cage counts were made so as to determine the percentage of parasitism at different times of the season. While making these counts the number of winged and wingless individuals was kept. No attempt was made to determine the sex because of the large numbers present. In the thirty-six cages of Sialis field material there were six cages in which the number of wingless forms exceeded those of the winged. In the series of elewen life history cages containing Chrysops egg masses there was only one cage that had in it more wingless insects than winged. So while winged individuals are usually predominant in the broods, now and then broods appear where the wingless form is predominant. Most of the cages containing a predominance of wingless insects were cages of material collected in the fore part of the season. The average percentage of winged forms in the sixty-six cages was seventy-five percent.

Chart Showing the Percentage of Winged and Wingless Individuals.

Data from Sialis Field Cages.

Cage No.	Date of Emergence	No. of Winged	No. of Wingless	Percent Winged	Percent Wingless.
1	7-2-26	110	68	61.8	38.2
2	6-29-26	32	69	31.7	68.3 *
3	6-29-26	141	159	47.0	53.0 *
4	7-2-26	14	28	33.4	66.6 *
5	6-28-26	91	107	46.4	53.6 *
6	6-29-26	210	151	58.1	41.9
7	7-1-26	92	34	72.2	27.8
8	7-4-26	30	5	94.2	5.8
9	6-28-26	307	165	65.0	35.0
10	6-29-26	100	35	74.0	26.0
11	7-1-26	55	60	47.9	52.1 *
12	7-3-26	75	25	75.0	25.0
13	7-4-26	25	5	83.4	16.6
14	6-30-26	50	18	64.8	35.2
15	6-28-26	60	24	71.4	28.6
16	6-28-26	105	55	65.7	34.3
17	7-1-26	1320	1200	52.5	47.5
18	6-28-26	125	100	60.0	40.0

Cage No.	Date of Emergence	No. of Winged.	No. of Wingless.	Percent Winged.	Percent Wingless.
19	6-28-26	80	25	76.2	23.8
20	6-28-26	216	144	60.0	40.0
21	7-1-26	225	131	63.3	36.7
22	6-26-26	38	11	77.6	22.4
23	7-2-26	325	245	57.1	42.9
24	6-30-26	226	69	76.6	23.4
25	7-2-26	155	50	75.7	24.3
26	7-2-26	32	22	61.5	48.5
27	7-2-26	700	180	81.7	18.3
28	7-2-26	186	109	60.1	39.9
29	7-1-26	2352	1755	57.2	42.8
30	7-7-26	5	11	31.2	68.8 *
31	7-2-26	1417	669	67.5	32.5
32	7-8-26	1595	1092	59.3	40.7
33	7-1-26	20	5	80.0	20.0
34	7-1-26	352	117	75.3	24.7
35	7-2-26	16,350	2070	88.8	11.2

The average number of winged individuals in the cages of Sialis field material is 75 %,wingless 25%.

Data from Sialis Life History Cages.

Cage No.	Date of Emergence	No. of Winged	No. of Wingless	Percent Winged	Percent Wingless.
2-4	7-16-26	121	25	82.9	17.1
2-5	7-14-26	62	76	44.5	55.5 *
2-6	7-14-26	153	53	74.3	25.7
2-7	7-14-26	169	21	88.9	11.1
2-9	7-14-26	139	35	79.9	20.1
2-10	7-14-26	116	26	81.7	18.3
2-11	7-14-26	153	50	76.2	23.8
2-12	7-14-26	516	220	70.2	29.8
13-1	7-15-26	233	96	70.9	29.1
27-4	7-15-26	239	55	80.6	19.4

Data from Chrysops Life History Cages.

Cage No.	Date of Emergence	No. of Winged	No. of Wingless	Percent Winged	Percent Wingless.
2-4-a	7-28-26	22	18	55.0	45.0
2-5-a	7-27-26	28	28	50.0	50.0
2-6-a	7-29-26	14	16	46.6	53.4 *
2-7-a	7-29-26	16	8	75.0	25.0
2-11-a	7-30-26	48	35	57.9	42.1
2-12-b	7-30-26	27	7	79.5	20.5

Data from Chrysops Field Cages.

Cage No.	Date of Emergence	No. of Winged	No. of Wingless	Percent Winged	Percent Wingless.
68	7-21-26	314	130	70.8	29.2
69	7-21-26	370	126	74.6	25.4
70	7-21-26	176	45	79.7	20.3
71	7-21-26	83	32	72.3	27.7
72	7-21-26	201	60	77.4	22.6
73	7-26-26	200	62	76.4	23.6
74	7-26-26	75	28	72.9	27.1
75	7-26-26	35	7	83.4	16.6
76	7-27-26	175	31	85.0	15.0
77	7-27-26	30	8	79.0	21.0
83	7-23-26	331	86	79.9	20.1

Total number of winged	31,357
Total number of wingless	10,407
Grand Total	41,764

Percent winged	.76
Percent wingless	.24

* marks cages where the number of winged is less than the number of wingless.

Habits.

In the field and in the cages the parasites continually moved about nervously over the egg masses and up and down the plant stems,walking much and flying little. While on the egg mass the females were constantly searching over it with their antennae;the males behaved in the same manner. Often the females were observed to stop to clean their wings,stroking them with the hind pair of legs as they pulled them down along beside the abdomen.

Copulation.

Most of the copulations took place on the egg mass where the males were always roaming and where the females returned from other parts of the cage. Suddenly a male would dash to a passing female,grasp her wing tips with his front pair of legs,hook his head over the tips,swing up and hold on the wings with the other legs . Thus hanging in an underslung position he would copulate with her, the act lasting usually from four to ten seconds. Then he dropped off and would perhaps immediately dash to some other passing female. One male was observed to copulate with three females in rapid sucession,getting off one and immediately on the next. Some females kept moving about while copulation was carried on,as tho attempting to shake the male off;others stood quietly. (See plate I, fig. 8)

Oviposition.

The parasite could oviposit in Sialis eggs that were in the center of the mass, only around the base of the micropyle. Any spot on the eggs in the outside rows seemed favorable, as was also true with Chrysops and Tabanus eggs. As Cameron observes, the egg to be oviposited in was apparently picked at random. When a Sialis egg was selected the female walked over it until a position for oviposition was reached. Then the wings were raised and the abdomen lowered between the micropyles until the ovipositor could be inserted in the chorion. With many females there was at first a slight back and forth movement as the ovipositor sawed thru the chorion. The female was then quiet until oviposition was complete.

The deposition of an egg inside of the host egg seemed to stop all development of the host egg, unless the host embryo had already used much of the yolk. It is not known just how old the host larva must be before it is able to tolerate the parasite and continue to develop. The parasites seemingly do not pay any attention to the age of the host egg. Both in the field and in the laboratory they were observed to oviposit in eggs that were almost ready to hatch.

Inside the laboratory the females oviposited any time of the day but when taken into bright sunlight they refused. All that were found ovipositing in the field were observed always after four o'clock in the afternoon. It is hoped that it will be possible to gather more data next summer on light as a factor in the oviposition behavior of this parasite.

Halloway [11] reports that he was able to induce a female Trichogramma to oviposit in the juice globules of okra plants. This fact might lead one to believe that a female will oviposit in any egg but it has been found that there are eggs in which they refuse to oviposit or to which they are not attracted. The writer was unable to get them to oviposit in Donacia or Gyrinid eggs, possibly because of the nature of the chorion, tho Gatenby [5] maintains in his embryological paper on Trichogramma evanescens Westw. that they will oviposit in Donacia eggs. However we believe that Mr. Gatenby is in error as to the identity of his eggs. (See plate I, figs. 5, 6 and 7)

What Gatenby more than likely had were the eggs of Sialis lutaria Westw., the most common Sialis of Europe. This insect is reported by several European writers as being one of the hosts of Trichogramma evanescens. His figure 2 (See plate I, fig. 5) is a very excellent outline of a Sialis egg that has lost its micropylar projection. All the Donacia eggs with which we are familiar, either in nature or in literature, are not set up on end as his figure 3A (Plate I, fig. 7) shows but are usually glued to the surface on the side. One species lays them setting one against the other at an oblique angle. The mass is not symmetrical as shown in Gatenby's figure 8 (Plate I, fig. 6)

In his text Gatenby describes his eggs as being of various shades of brown, depending on the stage of the development of the embryo within. Then it is stated that "the egg groups do not adhere very closely to the surface of the reed and they are easily removed by bending the surface on which they are laid", descriptions that fit Sialis eggs very nicely. All the Donacia eggs with which the author is acquainted or can find described, are not of a brownish color but are of an opaque white color. Sialis eggs are always of a brownish color. Even when the eggs are freshly laid they are of some shade of brown. Donacia eggs are glued firmly to their support and do not come off as easily as Sialis eggs do.

Harland (8) found that T. minutum refused to oviposit in the eggs of the Cotton Stainer (Dysdercus delaynei) and also that no attention was paid to various spider eggs.

Duration of Oviposition.

The following records were made at different times of the day on the duration of oviposition. The last two counts were taken of females that were fairly well spent.

Female No.			Female No.		
1.	-	15 seconds	7.	-	21 seconds
2.	-	20 seconds	8.	-	22 seconds
3.	-	20 seconds	9.	-	25 seconds
4.	-	20 seconds	10.	-	30 seconds
5.	-	20 seconds	11.	-	60 seconds
6.	-	20 seconds	12.	-	60 seconds

Number of Progeny of Each Female.

In the life history cages counts were made of the number of females put in and later progeny counts were taken so that in this way it was possible to find the average number of progeny per female.

Average Number of Progeny per Female.

Cage No.	Number Females	Number Progeny	Average No. of Progeny.
1.	4	15	3
2.	4	14	3
3.	15	138	9
4.	15	203	13

Cage No.	Number Females	Number Progeny	Average No. of Progeny.
5.	10	142	14
6.	15	250	16
7.	16	329	20
8.	12	206	17
9.	8	174	21
10.	8	190	23
11.	6	146	24
12.	16	736	46
13.	6	294	49
14.	4	350	87 (?)

Dissections of several females were made and the following ova counts obtained:

Female No.

1. - 30
2. - 30
3 - 40
4 - 47
5. - 47
6. - 48
7. - 50
8. - 52

Bodkin[2] in working with a very closely related parasite in British Guiana gives an idea of the maximum number of progeny that a single female will produce. He had one female make one hundred ovipositions from which eighty adults developed. Our cages at Douglas Lake were probably not observed over as long a period as his. Possibly the average number of progeny of the insects worked with at Douglas Lake was larger than the data given here would indicate. The average number of ova dissected from each female was forty-one, the maximum number fifty-two. The dissections were made in the afternoon on females that had emergrf on the morning of the same day. Cage number fourteen, where there was an average of eighty-seven progeny, is to be questioned until further checks can be made. No explanation is offered for the two exceedingly low cages unless these females had already spent themselves before they were put in the life history cage. Possibly some unknown factors entered, such as humidity and toughness of chorion.

Life History Studies.

As soon as the parasites began to emerge studies of the egg, larval and pupal stages were began. Considerable difficulty was encountered in obtaining parasite free eggs at times when they were needed. At first attempts to secure them were made by confining a number of Sialis adults in cages but few would ever lay while in captivity. At times a sufficient number of eggs were collected by going to the Scirpus patches about two o'clock in the afternoon and hunting females that were ready to or just beginning to oviposit. The stem on which the female rested was plucked and either held in the hand or put in a live jar while search was continued for others. On several days a large number of masses were collected in this way. Chrysops eggs were collected in the same manner. However the Chrysops female was much more wary than the Sialis female and would often fly,leaving the mass only partially laid.When kept in the live jar they usually flew off the stem upon which they were ovipositing and would finish on the sides of the jar.

In the laboratory a number of female parasites were released in the cages with the fresh eggs collected. The method of transfering eas simple. The mouth of the cage containing the eggs to be parasitized was turned upside down over the mouth of the cage confining the parasites. The females flew up,one and two at a time;others crawled up the sides of the cages. It was not necessay to turn the cages toward the light as these insects are negatively geotaxic.

The different stages of the parasite were searched for by dissection of the host egg. This was an unsatfactory method as the first stages are so nearly the color of the contents of the host egg that it was with considerable difficilty that the parasite was found. Often a whole morning would be spent without finding any of the early stages. When a stage was found,the dissected egg was kept on a slide in a moist chamber. The egg of the parasite was always lost when the slide was examined again. Possibly the dissection of the host egg caused it to collaspe. Sometimes it was possible to hold a mature larva or a pupa a short time,but it was never possible to carry them thru to emergence. Enough data were gathered in this way to determine something as to the length of the stages and other facts concerning the biology.

Attempts were made to keep some of the dissected material in a medium of the yolk of a hen's egg and also a medium of crushed eggs of the host but they failed rather miserably. To add to the troubles,fungus growths started very easily in spite of attempts to provide clean cultures.

Attempts were also made to watch development of the parasite thru the chorion. This was impractical with Sialis eggs as they are so dark that it is almost impossible to get a light thru them. With Chrysops eggs it was possible to get a light thru the chorion, but here the same difficulties arose as with dissection. How could one differentiate the parasite egg or larva from the yolk contents of the host egg ?

From the results obtained with preserved material it is believed that nearly the whole cycle can be followed by killing the eggs in hot alcohol and later dissecting. In this way the contents of the egg are coagulated and it is quiet easy to find the parasite. Some host eggs coagulate more easily than others.

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The Egg.

The eggs found in the host eggs were almost colorless. In general the shape is elongate-ovoid, being broad at one end and tapering to a point that is about half the width of the widest part. The shape varied for individual eggs. The following measurements were made of ova dissected from the ovaries of the female parasites. The measurements were made at the longest and widest part of the ova.

Measurements of the ova of
Trichogramma minutum Riley.

(Dissected from ovaries)

Length	Width	Length	Width
.089mm.	.003mm.	.112mm.	.036mm.
.089	.026	.112	.036
.100	.039	.112	.039
.100	.039	.115	.039
.100	.036	.115	.049
.102	.036	.118	.037
.105	.033	.118	.046
.105	.036	.125	.039
.108	.027	.132	.056
.108	.032	.138	.062
.108	.039	.138	.062
.109	.032	.140	.064
.112	.033	.148	.056

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Eggs of this insect found in the host egg measured from .108mm. to 120mm. in length and from .032mm. to .038mm. in width.

Length of Incubation.

The exact length of the time of incubation is not known. From dissections made of preserved material it is known quiet definitely that the period is twenty-four hours or less in lehgth.

The Larva.

The skin of the larva is of a transparent white color, while the contents of the body are usually of a dirty yellowish white, the same color as the contents of the host egg. The only appendages that the larva possesses are the two cone shape, straw yellow oral hooks. In a larva two days old they are .026mm. in length and .006mm. in width near the base. Authors seem to think that the function of the oral hooks is to "shovel" food into the mouth opening which lies just above their bases. The writer has slide mounts showing the mouth pressed tightly against the material of the host egg and with the oral hooks on the outside of the material. The oral hooks have never been observed to move in live material but there is no doubt but that their function is to help in getting food into the mouth.

There is no metameric segmentation of the body, tho in some specimens several creases and ridges appear, marking the cephalic end of the larva from the rest of the body. The whole organism is sac-like in shape, conforming to the cavity in which it rests. Where it is found at the end of the host egg, the larva is often pressed so tightly between the material of the host egg and the chorion that a finger-like prolongation of the cephalic end is found filling the space between the chorion and the rounding of the host egg contents. Gatenby tells us that in *Trichogramma evanescens* the tracheae, ordinary mouth parts, heart, and oesophageal valve are wanting. The same is true for *Trichogramma minutum*.

Food Habits and Growth.

The larva rapidly swallows the contents of the host egg until all have been crammed into the sac-like body (in the case of Sialis and Chrysops eggs). The skin of the larva grows thinner and thinner as more material is taken in, until the parasite fills the Sialis egg, and about two-thirds fills the Chrysops egg. Apparently not much digestion takes place until all the yolk has been swallowed so that there is no waste material to be defecated in the earlier development. Whether it defecates later is not known for sure but more than likely it does not.

Gatenby (5) asks how the larva of *Trichogramma evanescens* gets the yolk disclets from the caudal end of its body to the cephalic ? From our observations of *Trichogramma minutum* we would say that the material never lies at the caudal end of the body but that the larva keeps pressed against the chorion of the host egg so that as it grows in size it keeps the yolk disclets continually pressed forward. When the last disclets are to be swallowed they are at the cephalic end ready to be swallowed, rather than at the caudal end of the larva.

A larva that is between a day and a half and two days old is .120mm. in length while the prepupal stage, which is two or three days later, is .130mm. in length. Thus it is apparent that most of the growth comes about during the first days of the larval life. The larval and egg stage cover a period from six to seven days long. A prepupal stage follows the larval stage but nothing is known as to the length of it.

Number of Larvae in an Egg.

In Sialis and Chrysops eggs it would be a physical impossibility for more than one larva to reach maturity. In all dissections made only one larva was ever found in one of these eggs. Whether the females are instinctively aware of this fact is not known. Gatenby states that he rarely found two eggs in the sections of his supposed Donacia eggs. Tabanus and other larger eggs are able to support more than one larva and generally several are found in the larger eggs. In such eggs the parasite lays its eggs in such close proximity that it is a common occurence to find two larvae lying together in close contact,especially those at the pole ends of the egg. It is very doubtful if these larvae could injure one another except by causing starvation and this is not likely to happen in a Tabanus egg. As many as five larvae have been dissected from a Tabanus egg. Usually there are two at each pole and one in the center of the egg. Howard reports the largest number of parasites developing from one egg to be 10. These he obtained from one Browntail Moth egg. Kryger obtained thirteen adult parasites of Trichogramma evanescens emerging from lepidopterous eggs.

The Pupa.

The newly formed pupa is of a yellowish white color. As it grows older it gradually turns darker until two or three days before emergence it is of the same color as the adult,black. The measurements for the pupa are almost the same as for the adult. The total length averages 0.39mm., the width of the abdomen 0.30mm., and the length of the wing pads .039mm. When the life history runs fouteen days this stage is seven or eight days long. As is characteristic of this family, no cocoon is spun, the chorion of the host egg being sufficient protection. Sometimes the pupa is found laying upside down in the host egg.

Appearance of the Parasitized Host Egg.

As many authors mention, the host egg turns darker after it has been parasitized a few days. When the parasite has pupated, the egg turns black, possessing a peculiar sheen that marks it from non-parasitized eggs of the mass.

Emergence of the Adult.

Hungerford [13] has published the following notes on the emergence of this parasite from the eggs of the European Rose Slug, <u>Caliroa aethiops</u> Fabr. "From one egg one to three wasps issued. From one egg three came forth, one following the other in quick sucession. The tiny wasp cuts its way from the egg shell with its mandibles. The time required for the process in one case was thirty-five minutes from the first puncture of the egg until the wasp emerged. Where there are more than one wasp in the egg the second wasp sometimes enlarges, the exit hole of the first before attempting to pass. As soon as the wasp comes forth and while the wings are still pads it can jump an inch with alacrity. They fill out in about four minutes."

Emergence Response to Light.

Wolcott[17] in working with this parasite found that they show an emergence response to light. He had trouble with them being strongly positively phototropic,so placed his cages in the dark. When the cages were removed from the dark he found the greater number contained no adults but that in the next hour of exposure to light a large emergence took place. He came to the conclusions that "***** the normal time of emergence is approximately two hours after sunrise," and that in his cages,"****** six times(6.19) as many adults of T. minutum emerged in the first hour after being exposed to daylight,as emerged in the dark per hour of previous daylight in the same day. "

Length of Emergence.

On a check of some field material it was found that emergence in the same brood continues one and two days after the first day of emergence. No accurate check was made of other cages,as was done in the above mentioned, but it was noticed that in other cages the numbers were sometimes greater quiet noticably on the second and third days. In the same cages checks were also made on the length of the adult in the cage. In all four cages they lived for a period of four days.

Length of Life History.

The complete life history ran from fourteen to sixteen days in the Sialis cycle, which occurred during the fore part of the season. The greater number of parasites emerged on the fourteenth day. The average tempterature for this generation was 66.8 F. During the Chrysops cycle the period ran from thirteen to sixteen days, as in Sialis eggs. The temperature average reached its peak during this generation, being 75.4 F. The sixteen day cycle occurred in two cages, a Sialis and a Chrysops cage, that contained host eggs that were laid before the maximum average temperature was reached. Taking all the cages collectively, the average length of the time in the host egg was fourteen days. After the Chrysops cycle, the Tabanus cycle began, and probably other hosts also began to lay eggs at this time. At this period the average temperature was beginning to fall. No data were obtained from Tabanus eggs in the field because of lack of time and material. L.O. Howard and W.F. Fiske (12) record as short a period as nine days and as long a period as three weeks in the fall for the length of the life cycle in the host egg. Their work was done with the Browntail Moth in Massachussetts.

The following chart shows comparative data on the length of the life history in different cages.

LENGTH OF LIFE HISTORY OF
Trichogramma minutum R.

No. Days.	12	13	14	15	16	17
No. Sialis L.H. Cages	0	1	11	0	1	0
No. Chrysops L.H. Cages	0	8	1	1	1	0

****

Incubation Period of Host and Development of Parasite.

The parasite's life history cycle ran side by side with the incubation period of the host during the first part of the season. As the season grew warmer the incubation period of the host shortened while the cycle of the parasite remained at about the same place. Later in the season instead of finding the parasite emerging on the same day that the host larvae are hatching,it is emerging as long as twelve days after the hatching of the unparasitized host eggs.

The following chart gives comparative data.

Length of Sialis Incubation Compared With Parasite Emergence

From Field Material(Emergence from 6-26-to-7-8,26)

Days longer parasite in host egg than host incubation.	0	1	2	3	4	5	6	7	8	9	10	11	12
No. Cages	7	7	4	7	3	1	1	0	0	0	0	0	0

From Life History Material.(7-14 to 16,1926).

No. Cages	0	0	0	0	0	4	1	5	2	1	0	0	0

Length of Chrysops Incubation Compared With Parasite Emergence.

From Field Material (7-17 to 29,26.)

Days longer parasite in host egg than host incubation.	0	1	2	3	4	5	6	7	8	9	10	11	12
No. Cages	0	0	0	0	0	0	0	0	0	0	0	8	2

From Life History Material (7-20 to 25,26).

No. Cages	0	0	0	0	0	7	1	2	0	1	0	0	0

****

Number of Generations.

During the two months spent working with these parasites there were four sucessive generations upon which notes were taken. At least five other generations, not sucessive but overlapping each other and the sucessive four, appeared. A sheet made up of emergence dates of field material, life history cages, and field notes, show that there was an almost daily emergence of the parasite thruout the season. No distinct generations appeared.

How the Parasites Overwinters.

No one knows definitely just how the parasite does over-winter. L.O.Howard and W.F.Fiske[13] have published some temp-erature results that give a hint as to how this insect spends the winter. They say that "if the temperature falls below certain limits, the young parasites will hibernate or attempt to hibernate and thereafter their development may be delayed for several weeks, even months, even tho they are exposed to continous high temperature during this period." More than likely the winter is passed in some lepidopterous egg.

Percentage of Parasitism.

In studying the charts of percèntages of parasitism over the span of the season that the data were gathered, it can be inferred that in this particular season, and it would probably be true for other seasons, that the numbers of the parasite that sucessfully passed the winter were few. The first host eggs found were those of <u>Sialis</u> <u>infumata</u> Riley. These eggs were, with the exception of one cage, parasitized very lightly. Sialis eggs are laid in a single decked mass so that it is very easy for the parasite to reach all the eggs in the mass. The average percent of parasitism for the thirty-six cages of field material that were parasitized about the middle of June, was .019 percent for approximately 1,045,075 eggs.

The next host that followed was Chrysops. In making counts of these eggs two number had to be taken into consideration. The number of eggs actually exposed to parasitism, and the number of eggs in the whole mass. Tabanidae eggs are usually laid in heaped masses, so that many of the eggs in the mass cannot be reached by the parasite. In the field cages that contained material parasitized during the last part of June and the first of July, there was a parasitism of 11 % for 22,468 eggs, the total number of eggs in the masses. When only eggs exposed to the parasite were considered, the average was, of course higher, being 17% for 15,258 eggs.

The life history cages of the two hosts may be used as checks for the field material, for here all factors are practically the same for both hosts, which was not true in the field. Parasitism of the two hosts in the life history cages runs about parallel. The average for Sialis eggs is

16 %;for Chrysops eggs exposed to the parasite,20.8 %, and for the actual number of eggs in the masses, 11.5%. The average for these two percentages is 16 %. This would indicate that under the same conditions the Sialis eggs would be parasitized as heavily as the Chrysops eggs, which was not true in the field. One cage of Sialis eggs had a 40% parasitism,which indicates further that the parasite will parasitize Sialis eggs heavier than the data obtained would indicate.

On August 8th,1926,six masses of Chrysops eggs were picked at random in the field and later counts made by counting the number of parasite emergence holes. The emergence hole of the parasite is very distinctive and can be recognized quite easily. It is a round more or less jagged edged hole,while the host larva emerges thru a slit at the cephalic end of the egg. As the parasites emerged from these on the 10th of August,it is evident that they were parasitized sometime during the last part of July. The percent of parasitism of these masses was cut down because one mass was not parasitized,an unusual find in the field at this time of the season. The highest parasitism was 98% and excluding the mass not parasitized,the lowest was 90%. The average percent for the eggs exposed to parasitism is 86.7 % and for the number of eggs in the masses 59.8 %; these two figures average 73 %.

Thus as the season advanced, the larger the numbers of the parasite grew, but yet they lagged so that the host was allowed to establish a good sized brood before the parasite numbers were large enough to make any inroads on the numbers of the host. So the host is not threatened with extermination but rather parasitism aets as a factor in helping maintain the Balance of Nature. This is done by the reduction of what might be called surplus numbers of the host. This reduction lessens the danger of the species becoming exterminated by its own sheer numbers. Further more the reduction of these numbers prevents no more than a normal disturbance of some other species that might serve as prey.

About the same situation exists with the European Corn Borer. 1414 It has been published that " this parasite is of little value in the control of the European Corn Borer, except in subnormal seasons because its highest parasitism comes too late in the season to give the best results."

Now when the time of the season has come that the parasite has increased its numbers so greatly and the egg laying season of the old host is past, it must find another host or hosts to support the large numbers that are now in the field. Unfortunately the Biological Station closed at this time so we are only able to offer suggestions as to what host the parasite now goes. We collected two, large masses of Tabanus eggs and parasitized them in the labor- and then killed the eggs in hot alcohol.Later the eggs were dissected. It was found that there were usually three parasites in a single Tabanus egg. Often as many as five were found,as has been mentioned before. The number of eggs in a single mass was also greater than in a Chrysops mass,so that if the Tabanus masses became as numbrous as the Chrysops masses were,they could support the larger numbers of parasites as easily as the Chrysops had supported the smaller numbers in the earlier part of the season. As the parasite has a large host list it is probable that other hosts absorb the increase.

While Girault[7] seems to think that the abundance of food is the only factor of importance that acts as a check on this parasite,there are other factors that might be pointed out that probably play an important part in keeping the numbers of the parasite reduced. Dr. L.O.Howard and W.F. Fiske[12] have said that the toughness of the chorion of the host egg was effective in the reduction of parasitism by this insect in the case of the Browntail Moth. Harland[8] reports that the oviposition of the parasite is not effective at times with the Corn Worm(Laphygma frugiperda S&A)because the felty covering of the egg varied in the thickness so that with some eggs it was thick enough to keep the parasite out. Harland also thinks that they refused to oviposit in the eggs of the Bean Leaf Roller(Eudamus proteus L.) because of a thin layer of some viscous substance on the chorion that had a repellent effect on the parasite.

The willingness to oviposit is a factor in keeping the numbers reduced. The female will oviposit in an egg with an embryo almost matured as readily as it will in a fresh egg. Because of this trait many eggs are laid that perish soon. This was observed both in the field and in the laboratory. L.O.Howard and W.F.Fiske[a] mention in their report that this insect will oviposit in eggs containing embryoes, but their observations were limited to the laboratory.

Winter is probably a very important factor in the reduction of the seasons numbers. From the data collected it is evident that only a small number ever pass thru the winter sucessfully.

Conclusion.

This parasite is a very sucessful organism. One of the reasons for its sucess it because it has such a large number of hosts. From the present studies and from literature it can be pointed out that the parasite numbers rarely become so large as to effectually reduce the numbers of the host to any appreciable extent. The parasite palys its part in the reduction of the numbers of the host only at the end of the laying season when a "pruning" is of more value than harm to the host. Another reason for its sucess is that its numbers are reduced at the end of each season by winter.

Chart of Sialis Egg Parasitism.

From Field Material.

Material collected from 6/22/26 to 7/1/26.

Cage No.	No. of Sialis Eggs	No. of Parasites.	Percent of Parasitism.
1	5,075	178	.033
2	16,850	101	.006
3	150,000	300	.002
4	13,750	42	.003
5	30,875	198	.006
6	53,000	361	.006
7	12,870	126	.006
8	28,920	35	.001
9	61,000	472	.007
10	30,000	135	.0045
11	48,000	115	.002
12	50,000	100	.001
13	20,000	30	.002
14	25,000	68	.002
15	34,000	84	.002
16	70,000	160	.028
17	86,000	2,520	.003
18	57,600	225	.004
19	26,200	105	.008
20	47,705	360	.007

Sialis Field Material Continued.

Cage No.	No. of Sialis Eggs.	No. of Parasites	Percent of Parasitism
21	30,600	356	.012
22	48,300	49	.001
23	8,500	570	.065
24	85,600	295	.003
25	28,800	205	.007
26	16,000	52	.003
27	22,200	980	.044
28	85,600	295	.034
29	34,750	4,107	.118
30	46,000	16	.0003
31	26,400	2,086	.079
32	10,500	2,687	.255
33	19,200	25	.001
34	15,300	469	.030
35	8,000	3,200	.400
36	570,000	18,420	.320

39,457 parasites emerged from approximately 2,045,075 Sialis eggs,giving an average parsitism of .019 %.

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Chart of Chrysops Egg Parasitism.

From Field Material.

Cages 68 to 77 collected on 7/8/26, Cage 83 on 7/14/26.

Cage No.	No. of Parasites	No. exposed to Parasite	% of Parasitism	No. in Mass	% of Parasitism
68	444	800	.55	1,582	.281
69	496	2,175	.228	2,950	.168
70	221	1,508	.14	2,316	.095
71	115	1,090	.105	1,316	.084
72	261	2,000	.130	2,900	.090
73	262	2,146	.179	6,197	.132
74	103	810	.127	1,300	.079
75	42	1,235	.037	2,000	.021
76	206	1,010	.203	1,630	.126
77	38	1,195	.039	1,730	.021
83	427	1,965	.217	2,720	.157

2,615 parasites emerged from egg masses that contained approximately 22,468 eggs for average parasitism of 11.6%. The number of eggs actually exposed to parasitism was 15,258 eggs for an average of 17.1 %.

On Agust 8,1926 a number of Chrysops masses were collected that had been heavily parasitized. The following counts were obtained by counting the emergence holes. The parasites had been allowed to emerge in a large cage in the labratory.

Cage No.	No. eggs eposed to parasite	No. eggs with emergence holes	% Para.	Eggs in mass	% Para.
M-1	100	0	.000	170	.000
M-2	90	88	.967	160	.544
M-3	125	115	.928	175	.677
M-4	110	106	.964	160	.662
M-5	500	490	.980	650	.753
M-6	100	90	.900	170	.529

889 parasites emerged from egg masses that contained 1,485 eggs for an average percentage of .598. The number of eggs actually exposed to parasitism was 1,025 for an average parasitism of .867.

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Summary.

1. *Trichogramma minutum* Riley is found in both hemispheres.

2. It has a host list that numbers well over one hundred fifty species in seven orders.

3. The author reports *Sialis infumata* Newn., *Chrysops striatus* O.S., *Chrysops excitans* Walker, and *Tabanus lasiophthalmus* Macq. as new hosts.

4. The numbers of winged females usually exceed those of the wingless males and females.

5. This parasite reproduces parthenogenetically.

6. The author reports an abberant form that has the antennae clothed with long hairs.

7. It is believed that strong light has a negative effect upon the oviposition of this parasite.

8. While this insect has been known to oviposit in the juice globules of okra plants, yet it refused to oviposit in the eggs of Donacia, Gyrinidae, the Cotton Stainer(*Dysdercus delaynei*) and also paid no attention to spider eggs.

9. Gatenby's sections were made from Sialis eggs and not Donacia eggs.

10. The average number of ova dissected from the females was forty-one. The average number of progeny was twenty-three. The ova measured 0.089mm. to .148mm. in length.

11. The larva is a sac-like creature with no metameric segmentation of the body and the only appendages possessed are a pair of oral hooks. Tracheae are not present.

12. The larva rapidly swallows the contents of the host egg,no digestion taking place until the larva has distended itself to full size.

13. Only one larva is able to develop to maturity in the eggs of Sialis and Chrysops. Tabanus eggs usually support three. The maximum number of _T. minutum_ R. reported emerging from one egg is ten.

14. There is a prepupal stage but its length is not known.

15. The larval and egg stages last from six to seven days in a fourteen day cycle. The length of the pupal stage is from seven to eight days.

16. Wolcott proved that there is an emergence response to light.

17. The average life cycle ran fourteen days. The life cycle of the parasite ran from none to twelve days longer than the incubation period of the host.

18. In the same brood emergence continues for a day or two.

19. There were no clean cut generations. An almost daily emergence occurred.

20. The parasite probably overwinters in the egg, larval, or pupal stage in some lepidopterous egg.

21. Only a small number of parasites survive the winter.

22. Checks show that Sialis eggs are parasitized as heavily as Chrysops eggs when subjected to the same conditions. In the field Sialis eggs were parasitized very lightly.

23. In normal seasons the parasite numbers lag behind the numbers of the host eggs in the field until the peak of the host laying season is reached.

24. Toughness of the chorion,the thickness of the outside covering of the chorion,the viscosity of the substance on the chorion,willingness to oviposit in eggs of any age,the lack of virility of the female,and winter act as checks on the numbers of the parasite.

25. This parasite is very sucessful for it has a very large host list. It does not threaten to reduce its host's numbers materially except in abnormal seasons,and at the end of the season its large numbers are reduced very materially by the rigors of winter.

<u>Tiphodytes</u> <u>gerriphagus</u>(Marchal)(Family Proctotrypidae)

European Literature.

This very interesting parasite was first described by Marchal[21] in 1900 in the Annales de la Société Entomology de France as a new genus and new species, under the generic name Limnodytes. In 1902 Bradley in the Canadian Entomologist, Vol. 34, p. 179, proposed the new name Tiphodytes for Limnodytes, which was preoccupied. Marchal found the insect thru his embryological studies of Gerridae. He was first aware of the parasite's presence by the undulating movements of the larva which he could see thru the chorion of the egg. He first found larva that the third form of the parasitic larva of Platygaster resemble, described by Ganin. Later he found what he calls the first form of the larva which he thot differed from Platygaster's first form by the arrangement of the bristles and by the caudal hook which he thot was without a spine.

He imprisoned the adults in a glass tumbler and observed that they used their wings equally well in flying or in swimming thru water. His plates show that the males possess moniliform antennae while the females have clavate antennae. He gave no definite data on the life history. He mentions that he collected gerrid eggs on the 14th of May and that the adults of the parasite emerged in June.

In 1918 Henriksen[19] published under the old generic name Limnodytes, about the same information concerning the larvae that Marchal published, going into more detail on the description of the larvae. He published with his paper a plate showing the egg and three larval stages which he labels as Limnodytes sp. and marks " copied after Ganin ". Evidently his plates were not made from material at hand.

American Literature.

The only literature from America concerning this insect is the paper published in 1912 by Mathewson and Crosby[22] in the Annals of the Entomological Society of America, Vol. V, page 67, March, 1912. They describe the swimming of the species, the egg laying under water, and mention that their determination was verified by Marchal. The specimens that the author possesses were identified thru the kindness of Dr. S.A. Rohwer of the National Museum.

Field Notes Taken at Douglas Lake.

The adults were very numerous at the north-western end of the lake at Marl Bay and in Bessey Creek that emptied into the lake near the bay. They were found flying about the lily pads or walking over them. Sometimes only one female was on a pad and then again several were on the same pad. After the female landed on a leaf she usually walked straight to the edge of it. When a suitable spot was found,she first dipped her head under the surface film of the water and after a few struggles with it,suceeded in pulling herself entirely under water. Clinging to the underside of the pad,she walked about searching for gerrid eggs. Usually she did not have to search long as the gerrid eggs are laid along the under edge of the pad.

Oviposition was began as soon as the eggs were found. Several times the leaves were turned over under the water so that the female could be observed. After ovipositing in two or three eggs she would let go of the surface of the pad and come quickly to the top and fly away from the surface of the water. The passage thru the water from the leaf to the water's surface was so rapid that it was never determined if the wings were used or if the bouyancy of the insect's body brought it to the surface. More than likely she used her wings.

In the laboratory it was possible to watch oviposition more closely than in the field. As soon as the female entered the water she wrapped her wings tightly about her abdomen,making it appear much longer than normal. The antennae were held back over the head tightly against the dorsal side of the body with the clubs close together.The female leaned forward while ovipositing. This position made the insect appear as tho she were almost overbalancing herself by the strenous effort she was exerting in making the oviposition. The ovipositor was driven into the chorion of the host egg at an angle of 90 degrees. Usually no motion was noticed as the ovipositor was being thrust thru, tho sometimes a rocking motion was evident before the ovipositor had been thrust all the way thru the chorion. Thruout the operation the tip of the abdomen was held close to the chorion of the host egg.

In the field the writer observed a second manner of oviposition that neither Mathewson and Crosby nor others have observed. As usual the female alighted on the pad and walked to the edge but she did not go under the water. Instead she turned around and backed into the water and clung anchored to the lily pad with the front pair of legs, while the middle pair hung in the water, and the hind legs floated on the surface film of the water , as did the wings also. In this position the female was able to reach the Gerrid eggs with her ovipositor and oviposit in them. After ovipositing about twenty seconds the insect crawled back to the surface of the pad, wiped the abdomen off with the hind pair of legs and flew away to another pad.

In the laboratory females were observed to try to oviposit in the gelatine that covered the Trepobates eggs. Sometimes they attempted to oviposit in the gelatine as many as five or six times before finally striking an embedded egg. We were never able to determine that an egg was actually deposited. The female assumed the same position as when laying in a Gerrid egg and sometimes the rocking motion was noticed. No discrimination was made as to the age of the egg. Eggs containing Gerrid embryos almost ready to hatch were oviposited in as readily as eggs that were much fresher.

Technique in the Laboratory.

To carry on studies of individual eggs, slides were covered with paraffine and holes made in the wax to contain the egg. Each egg's number was scratched in the wax beside it. The slide was kept in a finger bowl in enough water to almost submerge it. This way the eggs were kept from drying and yet data could be kept on individual eggs. Paraffine wax did not prove very satisfactory as it broke loose from the slide after being in the water for a time and had to be watched very carefully to prevent the eggs from mixing. When further studies are made the slide will be covered with sealing wax.

Other laboratory studies were made with preserved material. This material was killed in boiling 70 % alcohol and kept in 70 % alcohol. Gerrid eggs did not seem to coagulate and become as dense and tough as Trepobates eggs.

In the laboratory the larvae or pupae could be easily seen under the binocular. Keeping the eggs under water, the chorion of the host egg was carefully cut and picked away with a small curved,and a flat knife-like dissecting needle,fashioned from steel insect pins and sharpened on an oil stone. After the chorion was removed the tough, rubber-like egg contents had to be cut open. A cross cut was usually made near the parasite. It will be found lieing in a cavity from which it can be picked. Considerable care must be used in removing the larva or the skin will be broken and the specimen ruined. The larva should not be allowed to become dry but should be put on a slide immediately. If they are allowed to dry the skin shrinks and sloughs off, leaving only the solid part of the body contents which are not particularly interesting. Better sucess may be had in mounting first and small second stage larvae by mountigg them in a bit of the host egg contents. By moving the cover-slip about, the larva can be moved into such a position that it can be easily seen.

The larvae were mounted from water to a gum arabic solution made up as follows:

Materials .

Glycerine---- 20cc.	Gum Arabic ----- 40gr.
Water ------- 50cc.	Chloral Hydrate -50gr.

When the gum is dissolved in water, dissolve the chloral hydrate in this and when dissolved, add the glycerine and filter. Do not mount specimens from alcohol but wash them first in water and mount from water to the slide.

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The Egg of T. gerriphagus(Marcahl)

The egg is of an ovoid shape with a micropyle that is about the same length as the egg itself and about a fifth as wide. The total length of Ova dissected was about .228mm and the width .059mm. at the widest part. Eggs found in Gerrid eggs measured .15mm. in length and .038mm. in width. These particular eggs had lost their chorion and micropyles when removed from the host egg contents. In the host egg they are placed at right angles to the median longitudinal axis with the micropyle pointing toward the point in the chorion where the ovipositor entered. It is usually so placed that either end is about equidistant from the chorion of the egg of the host. Ova dissected were for the most part almost transparent with a faint tinge of white over the chorion. Eggs found in the host egg have the contents around the center a greyish white and with the outside tinged a yellowish color.

Number of Eggs in Host Egg.

Usually several eggs are laid in a single Gerrid egg. Several females will lay at different times in the same egg. The greatest number known to have been laid in one egg is four. Three is the usual number.

The Larva.

The presence of the larva in the host egg is known by the undulating movement mentioned by Marchal. Henriksen[90] says that the larva of Anagrus brocheri Schulz,which lives under similar conditions,keeps the contents of the host egg stirred by turning and bending in different directions. We were never able to locate the larva of T. gerriphagus when it had the host egg contents in a turmoil. The first stage ~~first stage~~ larva no doubt can keep the contents stirred by whipping about with the row of spines around the abdomen. The second stage might keep them stirred in the same way. We are at loss to explain how the third form can keep the contents agitated.

What was apparently the center of disturbance was marked usually by a thin,bubble like ring that moved back and forth thru the contents of the host egg. If the oscillating movement was regular,it dissappeared for an instant when the end of the egg was reached, appearing again almost immediately and moving back to the opposite end,here dissappearing and reappearing as before. At times two such rings appeared simultaneously at both ends of the host egg. The second ring usually met the first one some where near the middle of the host egg where it dissappeared while the first ring continued. We can make no explanation for the appearance and dissappearance of the rings.

The appearance and dissappearance of the ring is sometimes regular and at others irregular. When irregular the time for the ring to pass from one end of the egg to the other is lengthened. At some periods the ring was not present but the back and forth flow of the contents continued. At other times scarcely any movement was seen. The following notes were taken on the irregular movements of full grown larvae almost ready to pupate. The time is the number of seconds that elasped between the dissappearance and appearance of the oscillating movements.

Larva No. 1.

First day.

15 seconds	Continous back and forth movement for 15 seconds
5 seconds	5 seconds
10 seconds	6 seconds
10 seconds	8 seconds
8 seconds	4 seconds
12 seconds	5 seconds
5 seconds	

Second day.

The oscillating movement was continous without irregular elaspes between the dissappearance and appearance of the ring.

Third day.

Movement continous but slower.

Fourth day.

No movement. Quiescent for pupation.

Larva No.2.

First day.

1 minute	20 seconds
40 seconds	16 seconds
20 seconds	12 seconds
20 seconds	25 seconds
25 seconds	15 seconds

Second day

Movements still irregular.

Third day

movements regular.

Counts were made of the number of mevements appearing in a half hour when the motion was continous.

Larva No.3 - 73 movements in 30 minutes

Larva No.4 - 65 movements in 30 minutes

Larva No.5 - 68 movements in 30 minutes

Larva No.6 - 70 movements in 30 minutes

Larva No.7 - 70 movements in 30 minutes.

The First Larval Stage. (Plate II, fig. 1)

Three distinct stages of the larva are found. The first stage measures from .10mm. to .16mm. in length. Some of the larger larvae of this stage measure .158mm. from the dorsal side of the abdomen to the tip of the caudal spine; the cephalothoracic region measures about .066mm. from the dorsal to the ventral side. The general color of this stage and the second stage is a greyish white, the same color as the contents of the gerrid eggs.

The newly hatched larva is divided into three regions. The head region is the largest of the three. At the apex on the ventral side, a pair of flattened, curved oral hooks are found. they are .017mm. in length from the tip to the base. Across the base the width is about .007mm. Just below the oral hooks is a chitinized, bill-like labium. The oral hooks can be moved about by the larva and can be crossed. The labium does not seem capable of such movement.

After the larva begins to feed the abdomen becomes more and more distended until it is larger than the head and thoracic regions. The thoracic region seems to fuse with the head region. A deep constriction now marks the cephalothoracic region from the abdomenal. On the dorsal and lateral sides of the abdomen is a row of flat spines. These spines are placed close together at regular intervals. They are .017mm. in length. As suggested before their probable function is to propel the larva about thru the egg contents. At the caudal end of the abdomen is the caudal horn(la corne caudale) that Marchal mentions. This is the appendage that posses the spine that he was unable to find. The total length of the horn is about .099mm. The tip, from the spine to the point, is rather slender, being between a third and a fourth as wide as the basal portion.

As there is not much difference in the size of the larvae of this stadium, it is probable that this stage extends over only a short time.

The Second Stage Larva.(Plate II and III)

The smallest second stage larva found, measured .184 mm. in length and .121mm. in width. The largest one found was .75mm. in length and .50mm. in width. The cephalothoracic region is no longer distinctly marked by a deep constriction. The general shape is ovoid.

Lying at a slightly sloping angle on the dorsal side of the cephalic region are two plate-like thickenings of the skin. These are each divided into a large oval lobe and a small more or less triangle shaped lobe having two sharp angles and a rounded angle. The two small lobes lie at the dorso-cephalic apex of the body. These details are not always distinct. Just between and a little beneath the rounded angles are the oral hooks on the ventral surface. These measure from .038mm. to .040mm. and from .019mm. to .020mm. in width at the base in the specimens that are at hand. The labrum is a short flap-like structure extending between the bases of the oral hooks. It has not been found in the other stages. The beak-like labium resembles that of the first stage differing principally in being larger and a little broader. It is found in the same position beneath the oral hooks. As in the first stage, the oral hooks can be crossed and moved about but the labium is stationary.

The spines on the abdomen are not any larger than those of the first stage. They have however a different arrangement. Instead of being spaced one by one at regular intervals, they are arranged in scattered groups of five or six.

Only a stump of a caudal horn is left. This is about the same size as the spine on the caudal horn of the first stage. It is placed on the median line of the ventral side, distad to the tip of the abdomen. Instead of curving upward as the caudal horn of the first stage, it curves downward.

It was found by a study of the material at hand that at the same time several larvae are present in one egg and that the first and second stages are cannabilistic. All three stages have been found together in the same egg. The first stage was found fastened to the second or third stage larva (Plate II, fig. 6) usually at the caudal end of the body. The larvae hold on by piercing the thick skin with the oral hooks and labium and by thrusting the caudal horn thru the skin. They live upon the body contents of the attacked larva. As more than one larva is almost always found in a Gerrid egg where a first stage is present, it is believed that the first stage is almost wholly cannabilistic. However if no other larva are present, it will feed upon the yolk disclets.

The second stage larva has been found feeding upon all stages. The first larval stage and the young larvae of the second stage are held clutched between the oral hooks and the labium. Sometimes the oral hooks pierce thru the skin and sometimes they do not. We have slides showing the crumpled larval skins of the first stage between the oral hooks and with the labium fastened in them. The larvae have been squeezed dry of their contents. When the larva is larger than the attacking larva, the stump of a caudal horn is also fastened into the attacked larva's skin. Where there are not enough larvae in the egg to complete one larva's growth, the last larva completes its growth by feeding upon the gerrid egg contents.

The Third Stage.

The smallest third stage larva found measured .813mm. in length and .40mm. in width. Larger larvae that were in the prepupal stage measured up to 1.375 mm. by .625mm. The length is somewhat longer than that of the pupae.

This stage differs very much from the first two stages. The body is elongate-ovate with the cephalic region indistinctly marked and not appearing to be any larger than the cephalic region of the second stage. The cephalic region with the oral hooks appear to have migrated some what caudad of their second stage position.

The oral hooks are very much reduced in size, being very slender and thread-like with broad bases. As compared with the second stage they are reduced in length and point cephalad instead of caudad as in the first two stages. In larvae measured their length was between .022mm. and .033mm. The width at the base was about .006mm. They are of an orange yellow color. The labium is not evident and the spines around the abdomen are also lacking as is the caudal horn. Probably not much feeding is done in this stage.

The Prepupal and Pupal Stages.

Almost all the third stage larvae that were dissected were in the prepupal stage. Probably this stage is as long or longer than the third larval stage. The transition from the prepupal to the pupal stage is not marked by a sudden sloughing off of the larval skin. Sometimes it does not break until the insect is ready to leave the egg of the host. It gradually disintegrates until it appears as a yellowish-white colored, thin blanket of pressed material covering the pupa. In most pupae it breaks up at this stage and collects along the ventral region around the legs and wings where it under goes further disintegration.

Congested masses often appear in the thoracic and abdomenal regions of the prepupal stage. Later in the pupa they become more compact and appear only in the abdomenal region. Here there maybe one or two masses of various shapes. Some are cigar-shaped,pear-shaped,cone-shaped, oval-shaped with a constriction in the center and various other forms. In live material they have been observed to change their shape from day to day. In older pupae they break up into small granules. This is waste material that is defecated by the adult.

The fresh pupa is of a lemon yellow color. At first the compund eyes and ocelli are of the same color but as the pupa ages they first turn pinkish-brown,then a reddish-brown and finally a very dark brown. After the eyes are dark colored,a black pigmentation of the other parts of the body become noticable. At this time the sutures of the abdomen appear.When the pupa has become fully pigmented it is of a jet black color,the same color as the adults.

The pupae fill the host eggs quite snuggly. Usually they are found lying on their dorsal side. When in this position and the time for emergence comes,they make a full half turn so that the exit hole is cut thru the sur- of the chorion opposite the side glued to the leaf surface. Some individuals are found lying on their sides. These do not make a turn before cutting an exit hole,but cut it thru the side of the egg.

Length of Pupal Stage.

On July 30,1926 four eggs that contained pupating larvae were isolated. On the 31st the new pupa could be seen. The red eye spots appeared on the 2nd of August and by the 11th the shining,jet black color was fully developed. The adults emerged on the 15th of August,making the pupal stage fifteen days long.

Size of Pupae and Adults.

The following data were obtained from specimens at hand.

Measurements of Pupa in Larval Skin.

	Total Length	Width of Abdomen
No.1.	.888mm.	.325mm.
2.	.888mm.	.325mm.
3;	.888mm.	.325mm.
4.	.937mm.	.450mm.
5.	.937mm.	.456mm.
6.	1.000mm.	.450mm.
7.	1.000mm.	.450mm.

Measurements of Pupae with Colored Eyes.
(Pupa in larval skin)

8.	.95mm.	.25mm.
9.	1.00mm.	.475mm.
10.	1.00mm.	.34mm.
11.	1.00mm.	.45mm.
12.	1.00mm.	.45mm.

Measurements of Partially Pigmented Specimens.

(Larval skin partially disentegrated)

Total Length.		Width of Abdomen.
No.13.	1.00mm.	.35mm.
14.	1.00mm.	.35mm.
15.	1.00mm.	.35mm.
16.	1.00mm.	.35mm.

Measurements of Wholly Pigmented Pupae.

(Some specimens almost covered with disintegrated material,others having it collected along the ventral region.)

No.17.	1.00mm.	.26mm.
18.	1.00mm.	.26mm.
19.	1.00mm.	.27mm.
20.	1.00mm.	.27mm.

Measurements of Adults.

No.21.	1.00mm.	.25mm.
22.	1.00mm.	.25mm.
23.	1.00mm.	.26mm.
24.	1.00mm.	.26mm.
25,	1.00mm.	.27mm.
26.	1.00mm.	.29mm.

We wish to call attention to the buttonhole-like slits that are found in the thoracic and abdomenal regions of the pupae and adults. In the thoracic region series of short slits are found along the margin of the sutures. Longitudinal slits are found in the second and third abdomenal segments. Nothing has been discovered concerning their function.

Percent of Parasitism.

Parasitism was very high in Trepobates eggs but only about a third as high in Gerris eggs. This is a peculiar fact when it is taken into consideration that Trepobates eggs are covered with gelatine, apparently making oviposition in these eggs more difficult than Gerris eggs. Observations show that the female parasites do have difficulty in locating the egg in the gelatinous matrix. Trepobates eggs were found on the same leaves with the Gerris eggs but the parasite seemed to exhibit a marked preference for the Trepobates eggs.

In the material at hand there was a parasitism of 23.9% for 3,017 Gerris eggs, while for Trepobates eggs it was 72.5% for 917 eggs. There were 128 rows of Gerris eggs. 10 of these rows were parasitized 100% and 10 parasitized 70% or over. Only 17.8% were parasitized 70% or over. Out of 47 rows of Trepobates eggs, 12 were parasitized 100% and 11 , 70% or over. Here almost half of the eggs, 48.9% were parasitized 70% or over.

Parasitism of Gerridae Eggs by <u>Tiphodytes</u> <u>gerriphagus</u>(M.)
(Gerris Eggs)

Row No.	No. Eggs.	No. Para.	Percent Para.	Row. No.	No. Eggs.	No. Para.	Percent Para.
1	34	14	41.1	25	50	0	00.0
2	44	14	31.8	26	6	6	100.
3	33	12	36.3	27	12	1	8.0
4	7	0	00.0	28	19	2	10.5
5	7	2	28.5	29	24	2	8.3
6	12	0	00.0	30	30	4	13.3
7	10	2	20.0	31	10	6	60.0
8	9	0	00.0	32	24	12	50.0
9	45	0	00.0	33	18	5	27.7
10	7	5	71.4	34	20	1	5.0
11	25	0	00.0	35	22	11	50.0
12	12	4	33.3	36	26	6	23.0
13	12	1	8.3	37	42	0	00.0
14	25	16	64.0	38	28	0	00.0
15	20	1	4.0	39	12	2	16.6
16	18	1	5.5	40	8	4	50.0
17	8	4	50.0	41	28	6	21.4
18	7	1	14.2	42	10	10	100.
19	24	3	12.5	43	15	1	6.6
20	30	5	16.6	44	100	0	00.0
21	21	2	9.5	45	26	6	23.0
22	20	20	100.	46	30	9	30.0
23	16	4	25.0	47	10	10	100.0
24	40	0	00.0	48	11	9	81.8

Row No.	No. Eggs.	No. Para.	Percent Para.	Row No.	No. Eggs.	No. Para.	Percent Para.
49	18	6	33.3	73	15	15	100.
50	8	4	50.0	74	20	4	20.0
51	14	7	50.0	75	100	0	00.0
52	21	9	43.8	76	12	3	25.0
53	14	4	28.5	77	20	8	40.0
54	6	6	100.	78	20	6	30.0
55	18	4	22.2	79	15	3	25.0
56	21	1	4.7	80	24	3	12.5
57	18	4	22.2	81	18	9	50.0
58	14	4	28.5	82	21	7	33.3
59	8	5	62.5	83	16	2	12.5
60	26	0	00.0	84	60	15	25.0
61	20.	2	10.0	85	75	0	00.0
62	10	1	10.0	86	100	0	000.0
63	20	8	40.0	87	10	0	00.0
64	40	0	00.0	88	42	2	4.7
65	20	1	5.0	89	21	3	14.2
66	45	0	00.0	90	14	6	42.8
67	24	2	8.3	91	14	4	35.7
68	22	10	45.4	90	36	4	11.1
69	14	2	14.2	91	12	1	8.2
70	20	1	5.0	92	14	1	7.1
71	40	4	10.0	93	10	9	90.0
72	30	2	6.6	94	36	36	100.

Row No.	No. Eggs	No. Para.	Percent Para.	Row No.	No. Eggs	No. Para.	Percent Para.
95	5	5	100.0	111	15	5	33.3
96	14	2	14.2	112	14	6	42.8
97	24	12	50.0	113	16	4	25.0
98	17	15	88.2	114	100	0	00.0
99	10	4	40.0	115	15	5	33.3
100	18	18	100.	116	38	36	94.7
101	28	7	25.0	117	20	1	5.0
102	32	3	9.3	118	30	10	33.3
103	15	12	80.0	119	15	15	100.
104	18	3	16.6	120	68	5	7.3
105	43	2	4.6	121	96	8	8.3
106	32	10	31.2	122	54	16	30.8
107	67	14	20.8	123	24	0	00.0
108	5	2	40.0	124	20	19	95.0
109	24	22	91.6	125	22	15	68.1
110	10	9	90.0	126	20	0	00.0

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(Trepobates eggs.)

Row No.	No. Eggs	No. Para.	Percent Para.	Row No.	No. Eggs	No. Para.	Percent Para.
1.	18	18	100.	7	20	19	95.0
2	18	16	88.8	8	18	18	100
3	16	8	50.0	9	20	2	10.0
4	6	6	100.0	10	28	14	33.3
5	21	19	90.4	11	60	60	90.9
6	60	60	100.0	12	10	5	50.0

Row No.	No. Eggs	No. Para.	Percent Para.	Row No.	No. Eggs	No. Para.	Percent Para.
13	48	35	72.9	29	8	4	50.0
14	36	26	72.2	30	12	1	8.3
15	14	12	85.7	31	24	6	25.8
16	22	22	100.	32	32	30	93.0
17	7	4	59.1	33	20	8	40.0
18	20	20	100.	34	14	14	100.0
19	10	10	100.	35	14	4	28.5
20	22	15	68.1	36	10	0	00.0
21	18	0	00.0	37	20	16	80.0
22	9	3	33.3	38	32	32	100.0
24	16	0	00.0	39	8	8	100.0
25	8	2	25.0	40	20	18	90.0
26	8	4	50.0	41	22	3	13.6
27	20	1	5.0	42	10	6	60.0
28	6	2	33.3	43	14	7	50.0
				44	14	14	100.0
				45	18	16	88.8
				46	12	0	00.0
				47	8	4	50.0
				48	10	2	20.0

In some of the above counts more than one row of eggs is included in the count.

Summary.

Tiphodytes gerriphagus(Marchal)lays its eggs in Gerris eggs in two ways. One by going under the water to reach them and the other by backing over the edge of the lily pad and reaching them with her abdomen and ovipositor.The larvae pass thru three stages. The first two stages are cannabilistic and also feed upon the yolk disclets of the Gerrid egg. Both the first and second stages make use of their oral hooks,bill-like labium,and caudal horn,to hold on to the attacked larvae while they are feeding on them. The row of flat spines around the abdomen is more than likely used to propel the larva thru the contents of the Gerrid egg. The third stage is elongate-ovate and does not ressemble the first two forms. It lacks the bill-like labium,the spines on the abdomen, and the caudal hook. The oral hooks are reduced in size. Probably most of this stage is really the prepupal stage. The pupal stage is 15 days long. A preference is shown for Trepobates eggs.

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Sialis infumata Newn.

Length of Adult Cycle.

On June 20 and 21,1926, great numbers of this insect swarmed alon the shores of Douglas Lake,Michigan. The males seemed to be at this time in greater numbers than the females. On the 22nd the numbers of females seemd to be greater than the numbers of males. At this time a great many eggs and pupae were collected,the pupae being found under logs,sticks and other debris along the shore. The pupae were dropped in a live bottle and when the laboratory was reached it was found that fully half the pupae collected had transformed to adults. All but one or two of this number were females. The following notes were kept on the abundance along the shore.

June	20	large numbers of males.
	21	large numbers of males.
	22	large numbers of males and females.
	24	Abundance of S. infumata continues.
	27	abundance of S. infumata continues.
July	1	abundance of S. infumata continues.
	2	abundance of S. infumata continues.
	5	numbers of S. infumata noticably decreased.
	10	very few S. infumata adults along beach.
	14.	two females found laying in a sheltered bay, the only two that were seen during the day and the last ones seen during the remainder of the season.

Egg Laying.

Davis'[23] observations were that they prefer to lay eggs "on undersides of boat landings,on the vertical sides of bridges and on stones projecting above creek or lake waters. They do not seem to select twigs of trees or shrubs when the above objects are acessible. The eggs are deposited on objects within limits of running water."

At Douglas Lake the most common object on which the eggs were found was Scirpus stalks which were standing in water from six inches to a foot and a half in depth. No eggs were found on Scirpus that was in deeper water. Eggs were also laid on the twigs of Pussy-willow and other plants that over-hung the water's edge. No eggs were found on the boat-landings around the lake. Searches were made for eggs around beach pools and on vegetation a short ways back from the water's edge but egg masses were found only once,these being on Scirpus that was eight or ten feet back from the water. The egg laying activities of the Sialis seemed to be confined to the south-east end of the lake,which was the point toward which the wind usually blew. No eggs were found around other parts of the lake.

On calm days great numbers of females could be found ovipositing,while on days when a strong wind was blowing, they were found under cover in the shrubbery along the shore. Sunshine did not seem to affect their laying activities as they were found depositing eggs in cloudy as well as sunny days.

Oviposition.

After alighting on a stem the female usually runs rapidly about over the plant, searching for other egg masses. It seems to be easier for her to use the mass of another female as a marker for the one she lays than to start a new one. Davis gives a short description of oviposition as follows: "The female deposits an entire row of from ten to twenty eggs and then begins another row--- she now moves backward over the mass to reach the place for the suceeding row; thus her wings and body cover the mass until it is laid. "

The writer is able to give a more detailed account of the laying. When an egg is about to be laid, the lips of the valves of the ovipositor fit tightly against an egg or eggs already laid. Then the tip of the abdomen is lowered until the fine hairs on the caudal tip of it touch the surface on which the egg is to be deposited. The valves open slightly and the egg comes down. It is covered with a sticky, brown cement that turns a darker brown upon drying. Some females secrete a cement that is much lighter in color than that of other females'. Where several females lay on the same mass it is usually possible to tell precisely, several days after the eggs are laid, one female's mass from another by the color of the eggs. Upon touching the plant's surface the tip of the egg is immediately cemented to it. The abdomen is raised with a forward swing toward the eggs or eggs opposite the one being deposited,thus setting the newly laid egg against its neighbors. The cement substance becomes dry immediately and thus the egg is cemented firmly to the leaf and to the eggs ajoining it.

Oviposition was as follows: The egg mass was composed of rows from 12 to 25 eggs long. A row was usually begun at the left end and the eggs were laid in one,two three, four order toward the right. From four to six eggs were laid. When the fifth or sixth egg had been laid,the opposite end of the row was begun and five or six more were laid. Then the female retunred to the unfinished left end and deposited five or six more eggs, This left to right and right to left action was continued until the row was finished at the center. Sometimes one or two more eggs were laid at the center for a new row. Then the left end of the new row was begun.

Laying was continous until about half the mass was complete,and then there was a pause of forty-five or fifty seconds,after which laying was resumed. Whether all females make this pause is not known,but all that were observed did. During the whole period of ovipositon the female is not easily disturbed and it was possible to pluck the plant upon which she was ovipositing and carry it about without disturbing her. When a mass of 300 or 400 eggs was complete the female flew away immediately.

The data for the following egg laying rates were secured from five females.

Female No.1	67 eggs deposited in 5 minutes.
	21 eggs deposited in 2 minutes.
	64 eggs deposited in 5 minutes.
Female No.2	60 eggs deposited in 5 minutes.
	61 eggs deposited in 5 minutes.
	23 eggs deposited in 2 minutes.
Female No.3	60 eggs deposited in $7\frac{1}{2}$ minutes.
	35 eggs deposited in 3 minutes.
Female No.4	60 eggs deposited in $6\frac{1}{2}$ minutes.
	60 eggs deposited in 6 minutes.
Female No.5	58 eggs deposited in $5\frac{1}{2}$ minutes.
	60 eggs deposited in 6 minutes.

Time of Oviposition.

No females were ever found laying during the morning or extremely late in the afternoon. Ovipositing females were found usually from midday until four or five o'clock in the afternoon.

Notes on a Kansas Brood of *Sialis infumata* Newn.

At Lawrence, Kansas further observations were made on the laying habits of a brood that has established itself at a reservoir on the campus of the University of Kansas. This place is popularly known as Potter's Lake.

The first insects found were males that appeared on April 9,1927. The only other record known of this colony is from a series of 12 males and 45 females collected by Mr. Robert Guntert on April 14,1922. As noted with the brood at Douglas Lake,Michigan,the males appeared two days before the females. The first eggs were found on April 12,1927,one day after the first appearance of the females. Egg laying extended over a period of seven or eight days. On one day no eggs were laid because of a downpour of rain and on another because of extreme chilliness. The manner of oviposition and the length of time required to lay the eggs were the same as at Douglas Lake. The last adults found were females seen on April 23,1927.

Incubation.

The incubation period of Sialis eggs at Douglas Lake covered a period from seven to ten days. The daily average temperature was 64° F. Here in Kansas the period was from 9 to 15 days. The average daily temperature from April 9 to 23,1927 was 57.2° F. Most of the larvae hatched on the 26th and 27th of April. The eggs laid on the 12th of April did not hatch until the 27th. A few masses hatched a little later.

Parasitism.

No parasites emerged from the Sialis eggs taken in Kansas.

Copulation of *Sialis infumata* Newn.

Several pairs were observed copulating and in each instance the procedure was the same. The female stood motionless, her head usually pointing toward the tip of the stem upon which she rested. The male approached from behind and crawled under the wings of the female until his head was even with her abdomen. He then curled his abdomen over the left side of his head, pushing aside his left pair of wings. As soon as the body of the male was in the shape of a letter U the tip of his abdomen came in contact with that of the female and then copulation was completed. The male remained in this position for 5 or 10 seconds, then straightened out and started to crawl away. Usually he came back and tried to copulate with the female a second time. In other instances the female refused to copulate and crawled rapidly away from the male. Several times as many as three males were seen to be following one female and many times two males followed the same female, but none seemed to be able to copulate with her on such ocassions.

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The following hatching dates are recorded from material that was being watched for parasitism at the Douglas Lake Biological Station of the University of Michigan. Large numbers of eggs were kept in a single cage.

Insect	No. Cages	Cage Date	Hatching Date
Ranatra	10	7/1/26	7/11 to 17/26.
Galerucella	2	7/1/26	7/7/26
	2	7/4/26	7/7/26
Donacia	4	7/4/26	7/7/26
	3	7/5/26	7/17/26
	1	7/6/26	No emergence.
Hydrophilus	2	7/4/26	7/7/26
	2	7/5/26	7/9/26
	2	7/8/26	7/17/26
Bothrothus	2	7/8/26	7/17/26
Notonectidae	4	7/8/26	7/24/26
	2	7/8/26	8/4/26
Zygoptera	2	7/8/26	7/24/26
	2	7/8/26	8/4/26
	1	7/26/26	No emergence.
Anisoptera	2	7/8/26	No emergence.
Gyrinidae	2	7/8/26	7/9/26
	4	7/22/26	7/22/26
	2	7/26/26	7/30/26
	2	7/4/26	7/17/26
Triaenodes	10	7/1/26	7/5/26
	2	7/1/26	7/7/26
Gerridae	6	7/22/26	7/24/26
	10	7/26/26	7/29/26
	2	7/26/26	7/30/26
	6	7/30/26	8/9/26
	1	8/2/26	8/10/26

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(For _Tiphodytes gerriphagus_ (Marchal))

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PLATE I.

Fig. 1. An egg of _Trichogramma_ _minutum_ Riley among the yolk disclets of the host egg, _Sialis_ _infumata_ Newn.

Fig. 2. Eggs of _T._ _minutum_ R.

Fig. 3. Antenna of abberrent form of _T._ _minutum_ R.

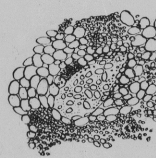
Fig. 4. Emergence holes(round holes) of _T._ _minutum_ R. and hatching slits of _S._ _infumata_ _N._

Fig. 5. Gatenby's fig.2.

Fig. 6. Gatenby's fig.8.

Fig.7. Gatenby's fig.3.

Fig. 8. _Trichogramma_ _minutum_ R. copulating.



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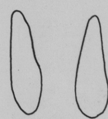

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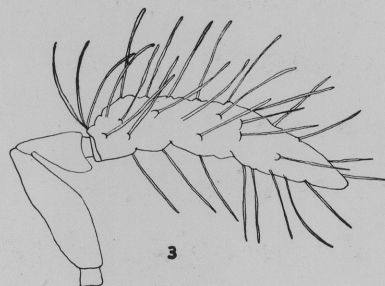

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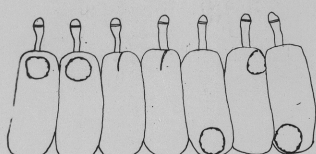

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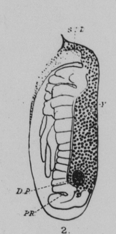

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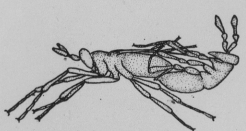

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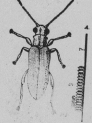

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Plate II.

<u>Tiphodytes gerriphagus</u>(Marchal).

Fig.1. Newly hatched first instar larva .

Fig.2. First instar almost ready to molt.

Fig.3. Egg of *Tiphodytes gerriphagus*(M.)

Fig.4. Ventral view of seconf instar larva.

Fig.5. Crumpled skin of an early first instar in the oral hooks of a late second instar. Note the tip of the labium fastened in the skin.

Fig.6. Third instar attacked by a first instar.

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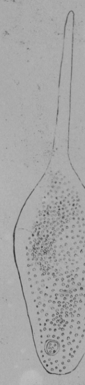

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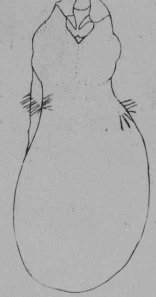

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Plate LII.

Tiphodytes gerriphagus(Marchal)

Fig.1. A dorsal-ventral view of the cephalic region of second instar larva.

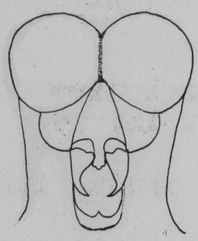
Fig.2. A non-typical second instar larva.

Fig.3. Abdomen of male with about one-third of penis extruded.

Fig.4. Lateral view of cephalic region of second instar larva.

Fig.5. Abdomen of female with ovipositor extruded full length.

Fig.6. Lateral-ventral view of second instar larva.



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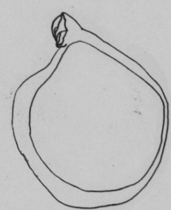

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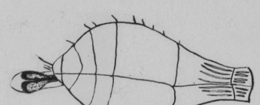

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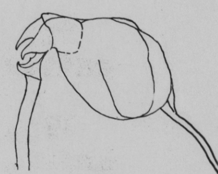

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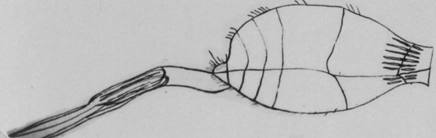

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